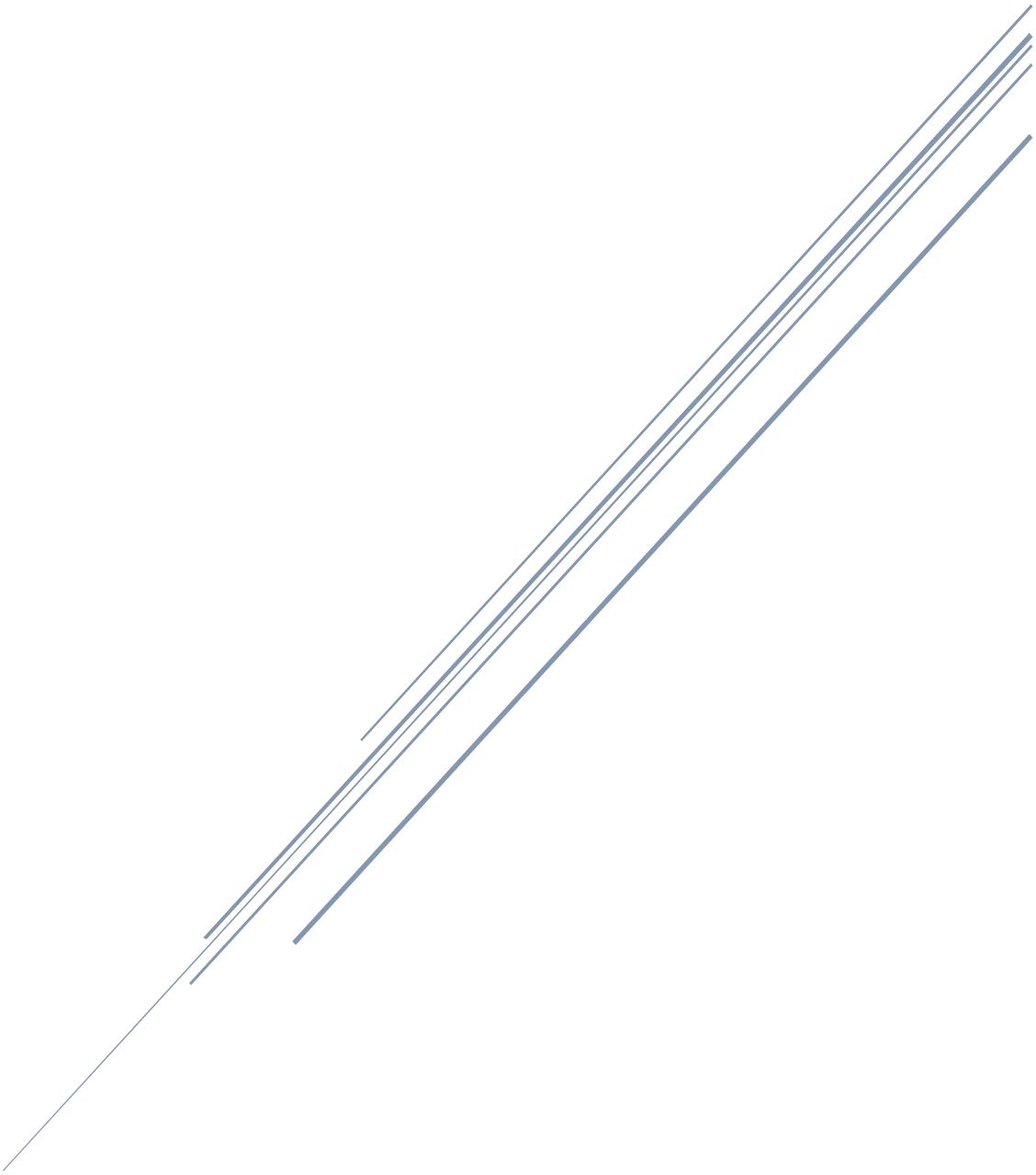
CHARACTERIZATION LAB

Experiment: 4

Characteristics of CB and CC Amplifier



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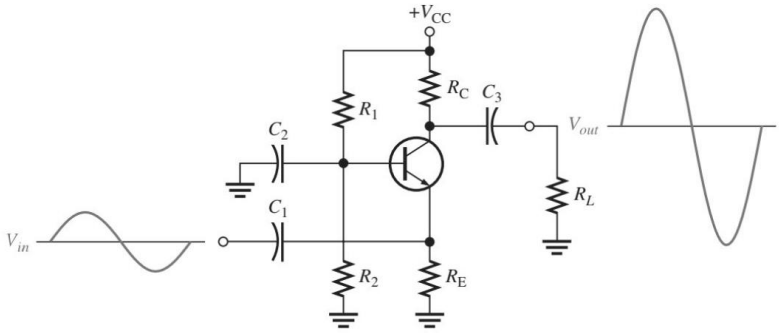
Aim

The aims of this experiment are:

1. To characterize common base (CB) amplifier.
2. To characterize common collector (CC) amplifier.

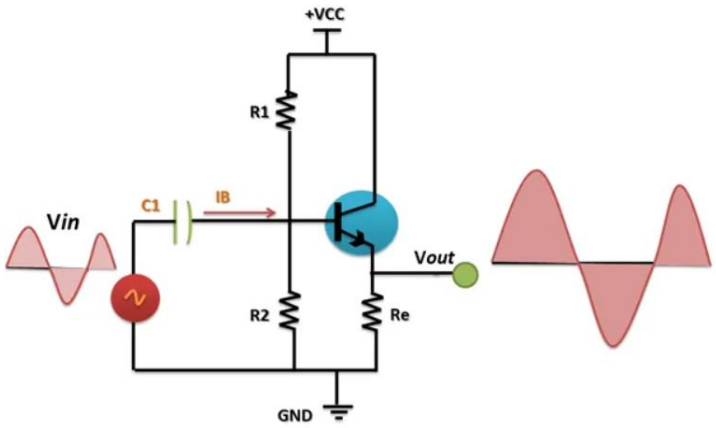
Theory

Common Base Amplifier



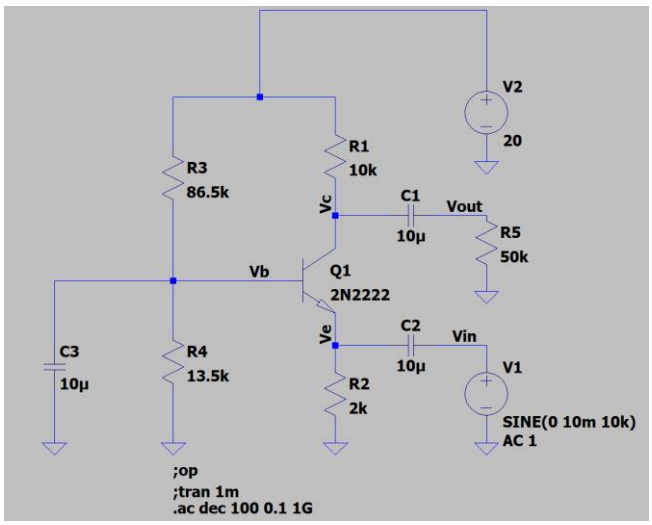
In a common base amplifier, the base is the common terminal, input is applied at the emitter and output is obtained from the collector. It has very low input impedance and very high output impedance.

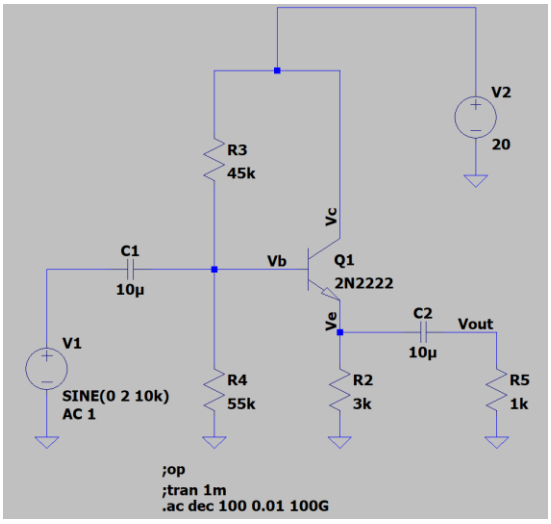
Common Collector Amplifier



In common collector configuration, the collector is the common terminal. Input is applied at the base and output is measured at the emitter. It has high input impedance and low output impedance.

Circuit Diagrams





Observations

1. **Common Base Amplifier**

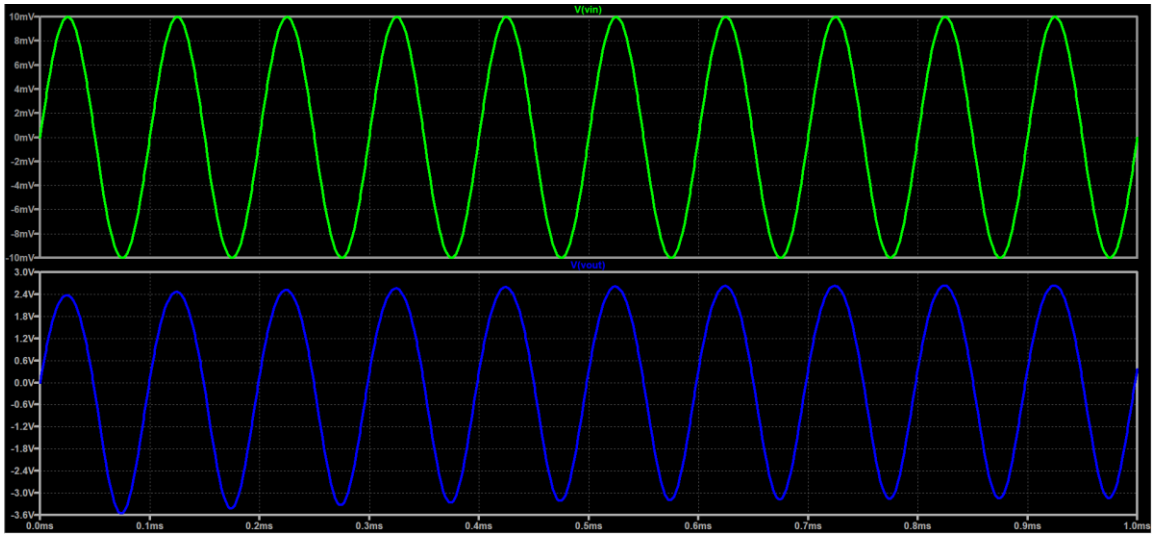
i. **Find out the DC operating point and check whether the circuit is in active region or not.**

It can be clearly seen that voltage at collector (**10.08V**) is more than the voltage at base (**2.64V**). The emitter voltage (**1.99V**) is lower than base voltage. This implies that the circuit is operating in active region.

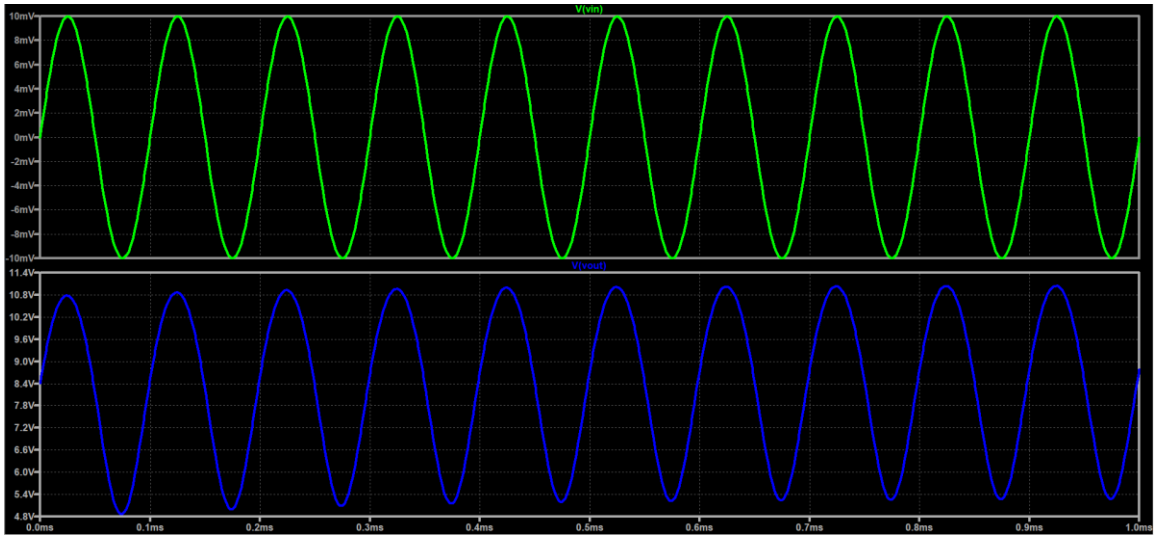
```
        --- Operating Point ---

V(vc):          10.0837         voltage
V(vb):          2.64594         voltage
V(ve):          1.99252         voltage
V(n001):        20              voltage
V(vout):        5.04185e-012    voltage
V(vin):         0               voltage
Ic(Q1):         0.00099163      device_current
Ib(Q1):         4.62906e-006    device_current
Ie(Q1):         -0.000996259    device_current
I(C3):          2.64594e-017    device_current
I(C2):          -1.99252e-017   device_current
I(C1):          -1.00837e-016   device_current
I(R5):          1.00837e-016    device_current
I(R4):          0.000195996     device_current
I(R3):          0.000200625     device_current
I(R2):          0.000996259     device_current
I(R1):          0.00099163      device_current
I(V2):          -0.00119225     device_current
I(V1):          1.99252e-017    device_current
```

ii. **Apply sine wave (peak to peak 20mV, 10 kHz) through a capacitor 10 µF at emitter. Plot input and out signal with respect to time with and without a capacitor 10 µF connected at collector of BJT.**

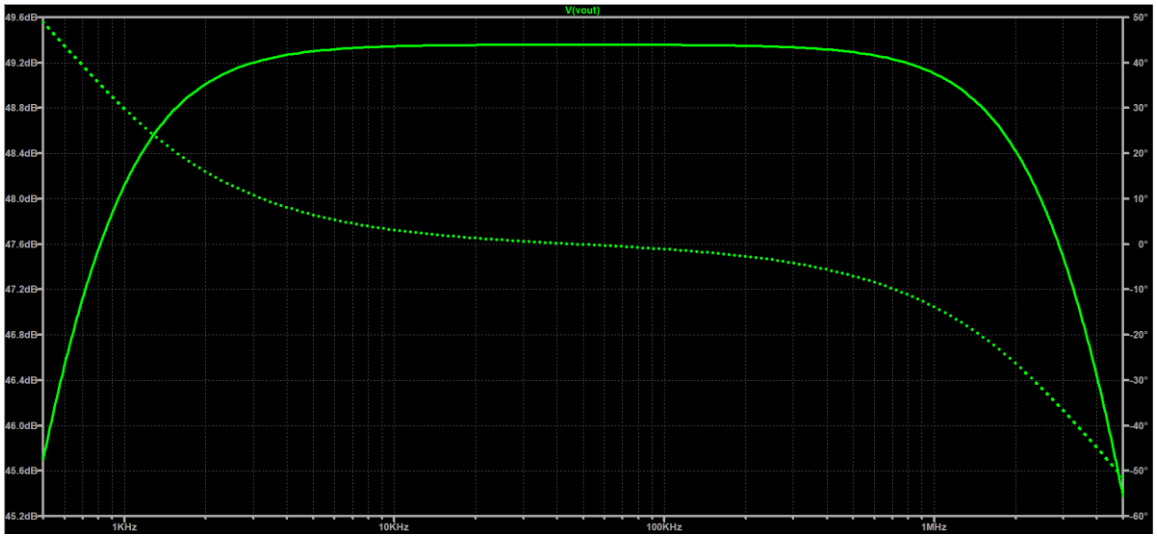


With capacitor at output



Without capacitor at output

iii. Plot Gain (dB) vs Frequency (500 Hz – 5 MHz).



iv. Find the Bandwidth of the amplifier.

The higher -3dB cutoff frequency is around 4.075 MHz. The lower -3dB cutoff frequency is 574 Hz. The bandwidth of the amplifier is 4.075 MHz as lower cutoff frequency is quite low.

2. Common Collector Amplifier

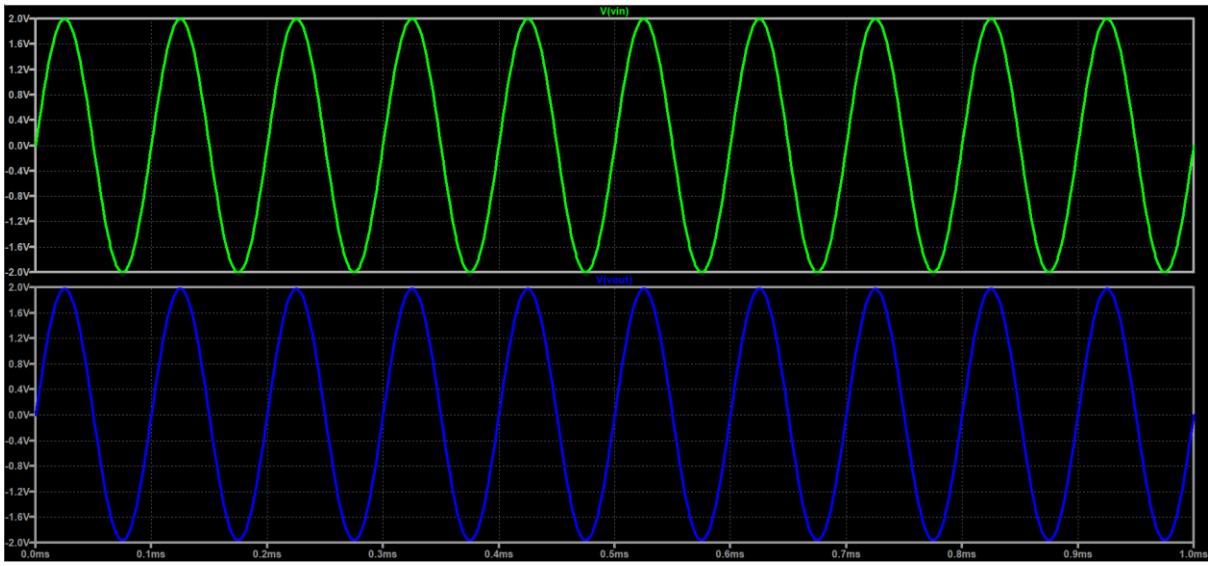
i. Find out the DC operating point and check whether the circuit is in active region or not.

It can be clearly seen that voltage at collector (20V) is more than the voltage at base (10.62V). The emitter voltage (9.93V) is lower than base voltage. This implies that the circuit is operating in active

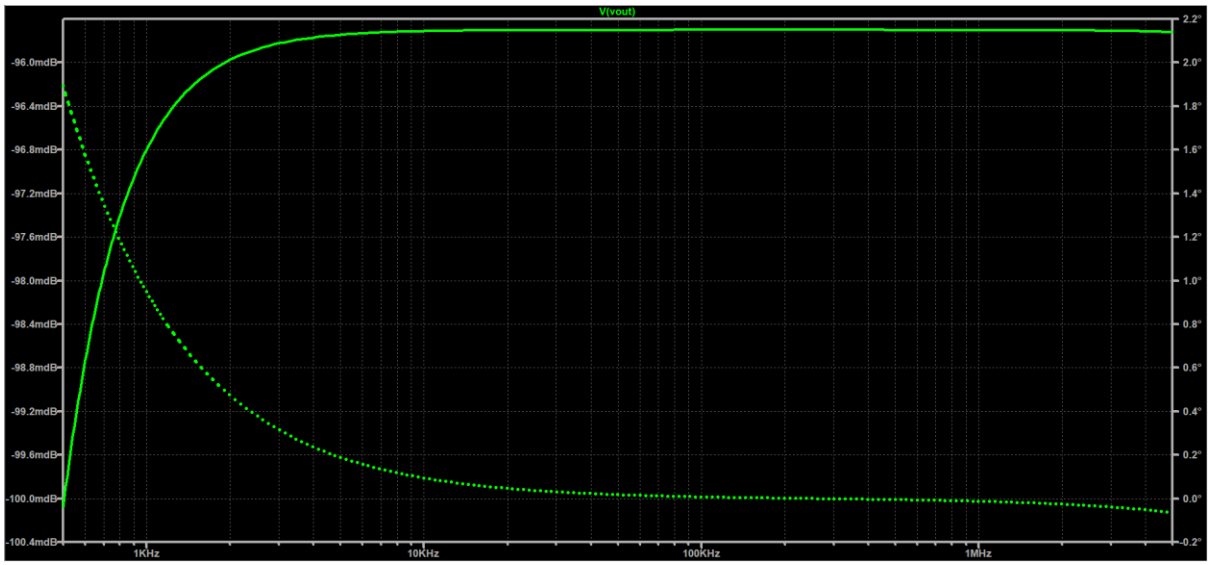
--- Operating Point ---

V(vc):	20	voltage
V(vb):	10.6232	voltage
V(ve):	9.93841	voltage
V(n001):	0	voltage
V(vout):	9.93841e-014	voltage
Ic(Q1):	0.00329758	device_current
Ib(Q1):	1.52258e-005	device_current
Ie(Q1):	-0.0033128	device_current
I(C2):	-9.93841e-017	device_current
I(C1):	1.06232e-016	device_current
I(R5):	9.93841e-017	device_current
I(R4):	0.000193148	device_current
I(R3):	0.000208374	device_current
I(R2):	0.0033128	device_current
I(V2):	-0.00350595	device_current
I(V1):	1.06232e-016	device_current

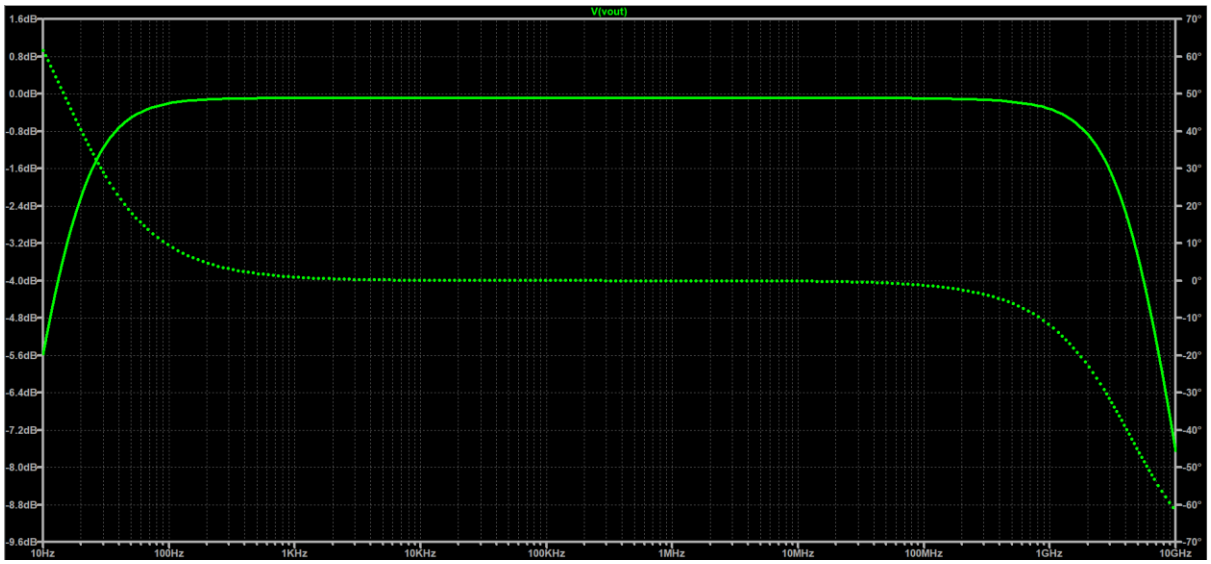
ii. Apply sine wave (peak to peak 4 V, 10 kHz) through a capacitor 10 µF at base. Plot input and output signal with respect to time. Output is measured at emitter of BJT. You may take RL = 1 KΩ.



iii. Plot voltage Gain (dB) vs Frequency (50 Hz – 50 MHz).



iv. Increase the frequency to check the bandwidth. Plot input current and output current and check the current gain of the circuit.



The higher -3 dB cutoff frequency is 4.582 GHz and the lower -3 dB cutoff frequency is 16 Hz. The bandwidth of the amplifier is 4.582 GHz.

Discussions

1. The common base amplifier has voltage gain given by

$$A_v = \frac{R_c}{\frac{1}{g_m} + R_E}$$

This implies that the amplifier is non-inverting as input and output signals are in phase.

2. The low input impedance suggests non-ideal signal source would not be able to apply any voltage to the input. Similarly, high output impedance means only a fraction of the output would come across load. Thus, practically CB is a poor amplifier configuration even though gain is high. It is generally used for impedance matching.
3. The common collector amplifier has voltage gain given by

$$A_v = \frac{R_E}{\frac{1}{g_m} + R_E}$$

Thus, the CC topology is also non-inverting as input and output signals are in phase.

4. The high input impedance and low output impedance make it perfect for connecting loads. However, since there is no amplification it is generally used as buffer circuit.

Results

	CB Amplifier	CC Amplifier
DC Bias Point (V)	10.0837	9.938
Gain (dB)	49.357	-0.095
Bandwidth (MHz)	4.075	4582